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A Study of the Culture of Cruciferous Vegetables in the Philippines

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INTRODUCTION

Distributed throughout the temperate regions of the world there are, in this family, about 218 genera and 2000 known species. Four genera and about six species, most of them introduced, occur in the Philippines, the most common being the mustard, the Spanish form of *Raphanus sativus*, and *Brassica pekinensis*. (1)

Though only minor crops in this country, cruciferous vegetables constitute a part of the daily food of the people, and for this reason their scientific study is worthy of attention.

The object of the present study is to examine into the results obtained in native methods of cultivation, comparing them with results possible under improved methods, such as better culture, fertilization and seed selection, using not only those strains commonly employed by the people, but in addition

certain imported foreign varieties. It is also the purpose of the writer to give some simple cultural directions, both for home and market gardens, together with a discussion of the soil and its preparation, as well as planting and marketing. An improvement in quality and increase in production per unit of area should result from the adoption of improved methods of culture.

Except by a few foreigners, the proper culture of these vegetables in the Philippines is almost unknown, although some attention has been given to their culture by the Bureaus of Education and Agriculture. Most of the farmers, by the crudest methods, raise just enough to supply the needs of their families a certain part of the year. To most of the people living in the towns the planting of these vegetables for home use seems to be of minor importance, though considerable attention is devoted

to the propagation and cultivation of ornamental plants. The growing of these salad plants to keep the table freshly supplied the year round should be a matter of interest to all householders in town or country. All usually have a piece of ground in their back yards which could be made suitable for plants like these. This small piece of ground, cultivated and planted with different salad plants, would undoubtedly be conducive to better health and cheaper living. In these Islands we need good supplies of salad plants as well as other vegetables, in order to increase the variety and improve the character of the common Filipino diet. "In reality these vegetables do not add greatly to the nutrients and fuel value except in relation to the cost, but they do increase the wholesomeness of the diet in three ways, viz: (1) by supplying it with necessary mineral matter less abundant in some other common food materials; (2) by providing bulk desirable for the normal digestion of more concentrated food materials, and (3) by making the diet more varied and attractive." (2)

The small patches of unused ground on many farms and near the majority of homes make it possible for almost any ambitious family to provide for a large part of their daily food necessities. The various kinds of animal dung, ashes and decaying vegetable matter are rarely used by the people. They can be obtained at little or practically no cost, except for the labor of hauling them. These natural fertilizers are not only valuable because they furnish plant food, but also because of their chemical and physical effect upon the soil, that is, to enable the land to hold moisture during drought. As the cruciferous crops have no permanent place, as do farm crops, in the agriculture of the Philippines, no effective efforts

have been made to increase their production. Any seed which would germinate has been acceptable and no farmer has thought it of importance to grow his own seed.

Marketing of Cruciferous Vegetables.—At present in the Philippines we are not able to make a more exact estimate of the amount of these vegetables consumed by the people than from observation in the markets. Since the beginning of October, 1915, the markets at Los Baños, Bay, and Calamba were visited many times, and two visits were made to the markets of Manila and to some of the markets of Rizal province.

Mustard and the Chinese long white radish were found to be sold in great amounts. The little red, round, early forcing radishes grown by the Chinese gardeners were found in Manila markets. The prices of all of these are variable, mainly depending on supply and demand. Where the supply exceeds the demand, the prices are low, and when the sale is small, due to the unsoundness of a large part of the produce, expenses are hardly paid.

In the markets these vegetables are handled under such conditions that they are exposed to dust, dirt, and the heat of the sun, causing them to wilt. These plants are generally eaten raw, hence they should be most carefully cleaned in order to attract purchasers. Mostly, ordinary Filipino farmers have given no attention to cultivating salad plants, not because there are no markets for the produce, but rather because of the difficulty in handling them. It is a mistake to be deterred for such reasons, since all such difficulties can be overcome by proper care in handling and management in transit and in the market.

The planters should always see to it that their produce is in the very best condition when taken into the markets.

It should be handled with great care so as to retain as much as possible of the natural flavor and crispness when sold. Wilting is due to the loss of water by evaporation and it may often be prevented by keeping the leaves, stalks, or roots moist, while those which are already wilted may be freshened in appearance by putting them in water.

Soil.—Any garden soil in good physical condition is suitable for these crops. It should be light, warm and "quick." Most of this family do not thrive well in clayey or heavy soils. In properly prepared clay loam they will grow well, provided that it is sufficiently drained so that in periods of excessive rains the water will not lie on the surface, causing the leaves to become yellow and the roots to decay. Well drained soils are preferable when the planting is to be done during the rainy seasons.

The soil must be rich with readily available plant food favorable for quick vegetation. These crops should be forced to grow as rapidly as possible because plants grown slowly become tough and hard, and the flavor is seriously impaired. In order to be attractive in appearance and to possess the most delicate flavor these vegetables should be grown in rich, mellow, friable soil.

Preparation of the Ground.—Thorough preparation of the soil for all salad plants is necessary to insure the most rapid development of the plants. The soil must be loose so that the roots can easily get through between particles of soil and draw their nourishment rapidly.

If a large piece of ground is intended for these crops, it should be plowed at least three times, then harrowed until the surface is smooth, fine and level, so that the germinating seeds can easily make their way to the surface of the

soil. The seeds being very tiny, good germination cannot be expected in soil composed of large lumps. Where only small pieces of ground are to be planted, dig the soil over with the spading fork several times and level the surface with a rake or similar tool. Remove all trash and break all lumps into fine pieces. If the soil is hard to work, as in the case of stiff and heavy clay, which is inclined to bake, manure and decaying vegetable matter may be added and carefully worked into the soil. Do not attempt to plow or turn the soil when it is very wet. The shearing action of the plow upon the bottom of a wet furrow is likely to form an almost impervious layer by making the soil particles compact. Unless the depth of plowing is varied from year to year this layer is likely to form a plow-sole hardpan. By gradually changing the depth of plowing or digging each year, new soils are brought to the top and mixed with surface soil without injuring its yielding capacity. Deep preparation not only increases available fertility, but also extends the area in which moisture and nourishment may be found, and the plants respond by sending feeding roots in all directions.

Necessity of Cultivation.—Every one should recognize the necessity for cultivation, even in a small piece of ground. But the native farmer does not know why such operations are beneficial. He rarely cultivates his kitchen garden at all. The soil is allowed to bake and become compact, so that the roots which support the whole body of the plant are not able to push themselves through and gather all the necessary constituents for the maintenance of normal growth. Digging, hoeing or other cultivation also stimulates the working of "living microbes in the soil which convert the insoluble and inert nitrogenous substances in the soil into nitrates of lime,

potash or other bases which being soluble in water are absorbed by the roots or root-hairs and furnish the plants with the nitrogen that is necessary for their development." (3)

Frequent cultivation should be the rule in growing all vegetables. A very liberal use of the cultivator or hoe to maintain a loose, shallow surface mulch is prerequisite to success. Cultivation loosens the surface soil, aids in holding the moisture, and destroys small weeds and pests. Proper and deep preparation of the soil, coupled with perfect surface mulch, will do much to obviate the necessity of watering.

Seed.—One of the factors which is often neglected in the production of these crops is the selection of seeds for planting. Small and imperfect seeds generally have low vitality. Such seeds may germinate, but the plants produced are generally weak and may not survive; or if they mature may produce plants of inferior quality. Only plump, strong seeds should be planted.

If, owing to the manner in which the seeds are stored and unfavorable weather conditions during the ripening period, the seeds are of doubtful viability, a sample should be taken and tested, either in seed flats or a container filled with fine sand or moist earth. In the seed flats, as there is sufficient soil, the seedlings can be allowed to grow to a considerable height (five to six cm.) to find out whether they are strong and vigorous or not. Sometimes seeds are tested by placing them between two sheets of blotting paper. If 90% do not show vigorous germination, other seed stock should be obtained or the amount to be sown per unit of area increased.

Manure.—In the countries where agriculture is well developed the value of animal manures as fertilizers is fully recognized. Very few Filipino farmers

have learned of their beneficial effects upon the soil and the value of the food materials that they give to the plants. Animal manures are usually a waste product in the Philippines, although they would certainly improve soil conditions materially, either in a fresh or well-rotted condition according to the kind of soil where they are to be applied. "If improvement of the mechanical condition is the main object sought, the best results will be obtained by applying the fresh manure to the heavy clay soil and well-rotted manure to the light soil. If, however, the prompt action of the fertilizing constituents of animal manure is desired, light soils are likely to utilize coarse manure to better advantage than heavy soils. Decomposition takes place slowly in heavy soils and the constituents of the fresh manure become available very slowly. In light soils, on the other hand, unless the season is dry, the conditions are such that manure decomposes readily and the fertilizing constituents are probably rendered available as fast as the plant needs them." (4)

During rainy seasons well-rotted manure should be applied to light soils shortly before it is likely to be needed by the plant, otherwise the fertilizing constituents will be carried away by drainage water. Well-rotted manure can be more easily applied or distributed on the soil than fresh manure because it is less bulky.

It has been found by experience that animal manures on clay soils have little or no effect on the first crop "on account of their slow decomposition; but since clay possesses very powerful absorbing properties the fertilizing constituents are retained in the soil and are finally utilized by the crop." (4) Manure, therefore, should be applied to clay soil a long time in advance of the planting of the crop. In drier soil during the dry season

it may produce little effect, but with sufficient quantity of moisture the action is considerable. "Fresh manure has forcing effect and tends to produce stems and leaves at the expense of fruits and grains." (4) It should be used, therefore, for early garden truck, or plants cultivated for their leaves, rather than for cereals or fruits.

Methods of Applying Manure.—There are three methods of applying manure: (1) The manure is placed in large or small heaps over the field and allowed to remain some time before being spread. (2) It is broadcasted, and allowed to lie on the surface for some time or plowed in immediately. (3) It is applied in the hill or drill with the seeds or seedlings.

The first method is objectionable because it increases the labor of handling, and uniform distribution is not secured. Besides, there is likely to be a loss by fermentation and leaching.

Spreading the manure and allowing it to lie on the surface should be practiced only on level places where there is no danger from surface washing. If the manure is spread a long while before the crop is planted on a leachy soil, there may be a loss of some soluble constituents.

Application in the drill or hill is useful where the supply of manure is limited and immediate effect is desired. For forcing truck crops this method is valuable. Only well-rotted manure is suited to this method of application.

Rate of Application.—There is no fixed rule by which manure may be applied. The rate will depend upon the character of the soil, the quality of the manure, the nature of the crop to be grown and the frequency of application. "Thaer, a German writer, states 15,500 to 16,300 kilos per acre to be an abundant application, 12,700 kilos good, and 7,300 to 8,200 kilos light; other German

writers consider 7,300 to 10,000 kilos light, 11,000 to 16,400 kilos usual, 18,200 kilos or more heavy, and 27,300 very heavy." (4)

When to Cultivate.—1. A crust forming over the soil after a rain or after watering is detrimental to plant growth and should be broken up as soon as the soil can be worked. To determine when the soil is sufficiently dry for cultivation apply the usual test of squeezing in the hand; when it crumbles and falls apart under moderate pressure, it is ready. Sandy soils can be worked sooner than clay soils.

2. After germination or when the plants are about 5 cm. above the ground the surface mulch should be restored.

3. Before the soil bakes.

4. Before a rain, so that a reservoir of moisture may be formed.

RADISH

Native Culture of Radish.—The radish is cultivated in the Philippines generally for its fleshy roots. The extent of cultivation varies in different places, while the methods employed are similar. In all school gardens this root crop can be found planted in drills; it is never sown broadcast as most of the farmers do. The native farmers usually plant radishes in small patches on their farms. Before sowing, coarse sand of about five times the quantity to be planted is mixed with the seeds. As soon as the seeds have germinated no further care is given, yet in some places large and fine roots are produced. This is largely due to the favorable soil in which they were sown and the climatic conditions. But if a farmer happens to sow radishes in a soil of unfavorable condition, which can only be improved by proper preparation and subsequent tillage, poor results are obtained. It is on this point that the local methods of culture demand consideration. The inferiority

of the produce is very noticeable, because the roots are of irregular form and of various sizes. The roots from seeds which were dropped on loose spots are usually of normal size, while those seeds dropped on the dense and compact places produce roots which are generally short, small and sometimes curved like a half-moon.

The fast growing plants are first harvested and the rest are allowed to remain until they are ready for consumption. Usually the first harvest is gathered five weeks after germination. Before marketing, the leaves are cut off, leaving only about seven to ten centimeters from the top of the root. Radishes are sold by the hundred; the minimum price is 20 centavos and the maximum is often 50 centavos per hundred. When the market is not overstocked large and fine radishes are sold as high as 70 centavos per hundred.

Radishes are used mostly as salad in the Philippines, but they are also eaten boiled with meat or fish. The young foliage is rarely used.

Culture in India.—According to Roy (5), "high and well drained sandy loam is invariably chosen for radish cultivation. All through the rainy season and after, the land is frequently plowed and thoroughly pulverized in preparation for these root crops. The seed is sown from the middle of August to the middle of November, 1.1 kilo per acre, and the field is immediately harrowed. Cowdung manure at the rate of 570 kilos per acre is applied directly after sowing. The crop is weeded and irrigated at intervals, and a month after sowing is ready for harvest. In many parts of the country the radish grows larger than an average good-sized carrot, and is eaten more as a vegetable than as a flavoring ingredient in salad. There are, in fact, several distinct cultivated species, the radish most common in Bengal

being a long, tapering root of a purplish rather than a scarlet tint. Roxburgh says that the root of the radish grows to the size of a man's leg or more and is only half immersed in the soil. The root is eaten raw and boiled and is occasionally pickled.

"The radish is cultivated not only for the root but also for the young seed pods and the leaves, all of which are eaten. The unripe pods are boiled and eaten or cooked in curries and are also sometimes pickled. Both roots and seeds yield on distillation with water a small amount of colorless sulphuraceous oil heavier than water. This is used medicinally."

PRESENT WORK

To determine the influence of horse manure, ashes and their combination upon the production of cruciferous vegetables that are commonly cultivated by the natives of the Philippines was one of the main objects of the present study.

The work was mostly confined to the Spanish radish and native mustard.

The experiment was begun in the month of May, 1915. Attempts were made to plant during the month of April, but it was too dry and no irrigation was available, thus the first planting was postponed till after several falls of rain in May. The seed which was planted was bought from the Chinese in Manila through the seed dealers of Calamba.

During the month of May, 1915, four plots in the trial bed were prepared.

On Plot 1 horse manure was applied broadcast at the rate of about three-fourths of a cubic meter per plot ($\frac{1}{200}$ Ha.).

On Plot 2 ashes were used (2 cement barrels).

On Plot 3 a combination of ashes and manure (1:1 K.).

On Plot 4 no application of fertilizer was made, in order to make a comparison with the fertilized plots.

These four plots were thoroughly prepared, dug up with spading fork, and each raked the same number of times until the manure and ashes were completely mixed with the soil. The fertilizers were applied two weeks before planting.

The seeds were sown fairly thick in drills, May 23, 1915. The distance between the rows was 50 centimeters. Either a hand-plow or a triangular hoe was used in making furrows to a depth of about 10 to 12 centimeters. The seeds were sown on the bottom of the furrows and then covered with fine soil to a depth of about two centimeters. After the seeds were sown and covered, the surface was pressed down until it was quite compact so that the moisture below the surface would be kept near the seeds to aid in germination. If the soil above the seeds is left loose there is a great danger of red ants eating some of them.

The seeds germinated the fourth and fifth days after sowing. In some parts of the furrows only a few sprouted. The seeds were found to be abnormal and shriveled and to have lost vitality.

A week from germination they were thinned to a distance of five to eight centimeters apart in the row. All seedlings that appeared to be weak were pulled up. Another thinning was made at the age of 15 days, leaving the plants about 10 to 15 centimeters apart in the row.

As the plants grew older the furrows were gradually filled up by constant cultivation. A distance of 50 centimeters between the rows permitted the use of a wheel hoe or hand cultivator, which can do as much work with one man as five men equipped with hoes can do.

Sowing radishes in drills insures an even distribution of the seeds and places them at a proper depth for germination, thus promoting a perfect stand. Seeds in drills can withstand drought better than if sown broadcast, as the plants develop a deeper root system, enabling them to absorb more plant food and moisture from the soil. Where the crop is drilled there is a better opportunity for the air and sunlight to penetrate the soil, an important factor during a moist season. Where radishes were sown broadcast or raked in, they were covered to various depths and germination was uneven. Cultivation and keeping up the proper soil mulch seem impossible for plants like these without considerable loss, if they are not drilled.

The crop was harvested July 7, 1915, and the whole crop from each plot was counted and weighed. The roots and tops were weighed separately as shown in the table below.

TABLE I

Plot	No. of plants harvested	Total wt. in kilos	Wt. of roots in kilos	Wt. of tops in kilos	Ave. Wt. of root in gm.
Manure.....	350	58.30	31.55	26.75	90
Ashes.....	300	56.70	29.74	26.96	99
Mixture.....	305	62.25	33.55	28.70	110
Check.....	333	57.70	28.98	28.72	87

Equal care in cultivation was given to these four plots.

In the first culture many good plants were saved for seeds. Some of them began to flower, but no pods or seeds were formed. The leaves turned yellow and gradually fell off.

SECOND CULTURE OF RADISH

The same method of preparation of plots, planting and cultivation as used in the first culture was employed in the following plantings.

During the life cycle of this culture there was a heavier rainfall than oc-

curred with the first culture. The seeds were sown in drills, 50 centimeters between the rows, on August 15, 1915, and the plants harvested October 10, 1915.

TABLE II

Plot	No. of plants harvested	Total Wt. in kilos	Wt. of roots in kilos	Wt. of tops in kilos	Ave. Wt. of roots in gm.
Manure.....	490	52.55	28.00	24.55	56.6
Ashes.....	336	38.74	20.80	17.94	62.0
Mixture.....	450	59.55	33.30	26.25	74.0
Check.....	489	46.95	24.45	22.50	50.0

The rainfall from the time of planting to harvesting period, that is from August 15 to October 10, 1915, was 54.11 cm. The time from planting to maturity was 56 days.

The plants that were left on the plots, for seeds, were all blown down and washed away by the storm on October 23, 1915.

THIRD CULTURE

Just after the storm of October 23, another planting was made. The seeds were sown in drills October 26 and the

plants harvested December 5th, 1915. The results are shown in the table below:

TABLE III

Plot	No. of plants harvested	Total Wt. in kilos	Wt. of roots in kilos	Wt. of tops in kilos	Ave. Wt. of roots in gm.
Manure.....	380	48.82	25.30	23.52	66.6
Ashes.....	362	49.80	27.15	22.65	75.0
Mixture.....	385	56.80	30.80	26.00	80.0
Check.....	378	36.81	19.27	17.54	51.0

Judging by these three successive cultures of radishes with fertilizer, the combination of ashes and horse manure has the greatest influence upon the production of roots and leaves. Ashes show a slight increase over the manure in the average weight of roots, and no difference in the weight of the leaves.

The results of these three cultures can be further compared by tabulating in the following form; that is, by taking the plots which give the highest average weight of roots with reference to the daily precipitation from planting to harvest, the physical condition of the soil from which they were grown and the time from planting to maturity.

TABLE IV

Time	No. of days from planting to harvest.	Rainfall in cm. daily Ave- -age	Total	Average wt. of root in gm.	Soil
May 23 to July 7, 1915.....	45	0.55	24.96	110	In the trial bed. Not well drained.
Aug. 15 to Oct. 10, 1915.....	56	0.96	54.11	74.0	In the trial bed. Not well drained.
Oct. 26 to Dec. 5, 1915.....	40	1.08	43.58	80.0	Northwest of new Labor- atory. Loose soil and easily drained.

The first planting shows that in a soil which is not well drained and with an average rainfall of 0.55 cm., this variety of radish matures within 45 days. With the same kind of soil and a rain-

fall of 0.96 cm. daily, 56 days is required. In a light and well drained soil, it took only 40 days, although the rainfall (1.08 cm. daily) was exceedingly high as compared with the first two cultures.

TEST OF SOME FOREIGN VARIETIES OF
RADISH

The Agronomy Department received many varieties of radish from J. M. Thorburn & Co., New York. The following have been grown:

<i>College No.</i>	<i>Names</i>
4718.	Long White Vienna or Lady Finger Radish
4740.	Cooper Sparkler Turnip Radish
4783.	Early Triumph Radish
4742.	Early Scarlet Turnip White-tipped Radish
4784.	California Mammoth Radish
4736.	French Breakfast Radish
4743.	Scarlet Gem White-tipped Forcing Turnip Radish
4727.	Early Round White Forcing Radish
4741.	Early Deep Scarlet Turnip Radish
4745.	Early Scarlet Globe-shaped Turnip Radish
4716.	Round Scarlet China Radish
4733.	Olive-shaped White Forcing Radish
4709.	Long Icicle Radish
4712.	Half-long Black Spanish Winter Radish
4721.	Half-long Deep Scarlet Radish
4707.	White Stuttgart Summer Radish
4723.	Olive-shaped Scarlet Radish
4782.	Celestial Winter Radish
4715.	White Strassburg Summer Radish
4738.	Early Non Plus Ultra Turnip Radish
4719.	Half-long White Forcing Radish
4720.	Half-long Delicacy Radish
4732.	Olive-shaped Brightest Scarlet Forcing Radish

There are two principal forms of radish that have been tested, the long-

rooted and the turnip-rooted. The former is the more tender and delicate of the two, but the latter requires less care in cultivation.

The seeds were planted in drills, and as soon as the plants were up they were thinned slightly to three to four cm. to prevent crowding. Some of the earlier sorts matured in three to four weeks after planting. To avoid the necessity of thinning for these varieties of radish the seeds must be sown carefully, the first radishes being pulled as soon as they are of sufficient size for table use, thus making room for those that are a little later.

Each variety was sown in three drills of four meters each, or in rows of 12 meters with one-half meter between the rows. They were planted November 11, and thinned (or the first harvest of those that were ready) December 1st, 1915. The last harvest was on December 29th, 1915.

The result is shown in the following table with the total weight of the produce per row of 12 meters each, and the separate weight of the roots and tops.

TABLE V

<i>College No.</i>	<i>No. of Plants Harvested</i>		<i>Total Wt. in kilos</i>		<i>Wt. of Roots in kilos</i>		<i>Wt. of Tops in kilos</i>		<i>Average Wt. of Root in gm.</i>	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
4718.....	51	52	1.818	2.760	0.918	1.640	0.900	1.120	17.8	30.5
4740.....	60	54	1.628	2.210	0.784	1.260	0.844	0.950	13.0	23.0
4783.....	63	56	1.788	2.000	0.913	1.260	0.875	0.740	14.4	22.5
4742.....	46	51	1.216	1.980	0.616	1.110	0.600	0.870	13.4	21.0
4784.....	..	45	....	3.540	....	0.540	....	3.000	....	12.0
4736.....	60	59	1.740	2.550	0.840	1.305	0.900	1.245	14.0	21.0
4743.....	..	54	....	1.950	....	0.660	....	1.290	....	12.0
4724.....	48	78	3.024	4.320	1.104	3.200	1.920	1.120	23.0	41.0
4741.....	57	64	1.775	2.540	0.855	1.380	0.920	1.160	15.0	21.0
4745.....	49	54	1.980	2.850	0.980	1.800	1.000	1.050	20.0	33.0
4716.....	60	44	3.100	3.530	1.260	1.490	1.840	2.040	21.0	34.0
4733.....	45	65	1.362	2.420	0.722	1.400	0.640	1.020	16.0	21.5
4709.....	58	40	1.886	2.390	0.936	1.400	0.950	0.990	16.0	35.0
4712.....	..	67	....	3.900	....	1.800	....	2.100	....	27.0
4721.....	42	50	2.087	3.000	0.987	1.560	1.100	1.440	23.0	31.0

Another planting was made December 1, 1915, but a week later all of the newly germinated seeds were washed away by the rain of December 7 and 8, 1915.

They were replanted December 17th, with the results given below:

First harvest, January 14th, and second harvest, February 15th, 1916.

TABLE VI

College No.	No. of Plants Harvested		Total Wt. in kilos		Wt. of Roots in kilos		Wt. of Tops in kilos		Average Wt. of Root in gm.	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
4707.....	40	64	0.840	5.030	0.360	1.890	0.480	3.140	9.0	29.0
4723.....	50	138	1.900	6.900	0.900	5.796	1.000	1.104	18.0	42.7
4782.....	..	80	....	8.400	....	5.100	....	3.300	....	63.6
4715.....	..	57	....	6.170	....	0.650	....	5.520	....	11.4
4738.....	..	53	....	1.550	....	1.100	....	0.450	....	20.0
4719.....	40	198	0.730	7.970	0.330	5.138	0.400	2.832	8.0	25.8
4720.....	..	200	....	9.120	....	4.000	....	5.120	....	20.0
4741.....	..	106	....	3.900	....	2.040	....	1.860	....	18.3
4718.....	48	80	1.940	1.000	1.100	5.400	0.840	4.600	22.9	69.0
4732.....	..	96	....	2.900	....	1.520	....	1.480	....	15.8

Most of these varieties are just as fine as the native radish and some have as delicate a flavor. Comparing the fleshy roots for which they are cultivated, these varieties are much smaller than the variety that we have grown in the Philippines for a long time; but a greater number of these new varieties can be raised per unit of area, since they can be grown closer together than the Philippine variety. Of all of these, only Nos. 4718 and 4782 grow as large as the native radish.

Since we have already in the Philippines a variety of radish, that is, the Spanish form of *Raphanus sativus* which is widely distributed and which suits the taste of the natives, perhaps it is not worth while to introduce foreign varieties as substitutes, unless variation in colors and in shapes are desired so that the supply of the table may be varied and attractive. I do not see any advantage in growing these foreign varieties in the Philippines, except those early sorts which can be ready within about three weeks, if properly grown. However, if the local markets demand the foreign varieties it would be well to introduce them.

MUSTARD

Native Culture.—Among the garden leaf crops cultivated in the Philippines mustard is the most common. It is cultivated in most parts of the country,

but only to a limited extent. The methods of planting in various parts are similar. The ground is thoroughly pulverized by plowing and harrowing. When the ground is moist the seeds are broadcasted. In order to have an even distribution of seeds, coarse sand of about five to six times the bulk of seeds to be sown is mixed with them. The surface of the ground is again harrowed after sowing, so as to cover the seeds with soil. For this purpose a rake is sometimes employed. Thinning is rarely practiced, and if done, it is at the end of three weeks, when some of the plants are about ready for the table. The remaining plants will have more space and grow larger and faster than those that were pulled. No further care is given except weeding.

On steep slopes and cañons, the spaces planted with mustard are rarely plowed. After the surface is cleared and all lumps are removed with a hoe and rake, the seeds are sown. The application of manure or any fertilizing constituent is never practiced.

By the few householders that have home gardens the usual method of planting mustard is to sow the seeds first in a small space set aside for a seed bed. After two weeks the seeds are transplanted, 25 cm. apart in the row and 35 to 40 cm. between the rows. The newly-transplanted seedlings are shaded during hot days with banana or

palm leaves until they are large enough to withstand the direct heat of the sun. They are occasionally irrigated by pouring water over the leaves.

Mustard is sometimes sown as an intercrop with other vegetables, such as peppers and eggplants. It shades the ground and lessens the rapid evaporation of moisture. The plants produced are small and of light color.

The greatest mistake of the local farmer is in the selection of plants for seeds. Selection is usually made when most of the biggest and most attractive plants have been harvested. Only those that are of medium size and slow growth are allowed to remain. With such a method of selection, improvement of the crop can not be expected. It may be improved slightly by proper preparation of the ground, planting and cultivation, but the improvement will not be as great as if the seeds had been selected from exceptional plants. Due to this practice, the plants produced by the natives are generally of inferior type. It is known by the local farmers that the highest possible gain can be obtained only from good produce, but they do not realize that the selection of superior plants for seed stock is the primary factor in obtaining the best results.

The mustard, called *mostaza* by the Spaniards, was introduced into the Philippines from China. It was brought to India and China from Europe. This mustard is "an erect branched, glabrous annual, 0.4 to 1 meter high. Leaves of the wild form are 5 to 15 cm. long, but the cultivated form is much larger, thin, oblong-obovate to oblong lanceolate, irregularly toothed or subentire, or the lower ones lobed or pinnatifid, flowers yellow, 6 to 8 mm. long. Pods ascend-

ing, linear-lanceolate, 1.5 to 3 cm. long. some contracted between the seed, the beak seedless." (1)

Sources of Seeds.—An attempt was made to collect seeds from different places in the Philippines, but the reply of most to whom I wrote was that the farmers buy their seeds in Manila. A considerable amount of seed was received from Mindanao and from Morong, but these failed to germinate; they were probably old seeds. The seeds used in this experiment were bought in Manila.

FIRST CULTURE

Mustard was planted in four different plots, which were prepared and fertilized in the same way as the plots that were planted with radishes.

The seeds were sown in drills on May 23, 1915. The furrows were about 10 cm. deep with 50 cm. between them. The seeds germinated five days after sowing. As the young plants were crowded in the rows they were thinned by pulling up all weak and unhealthy plants, leaving the standing plants 10 to 15 cm. apart. A week later, they were again thinned, leaving the plants 15 to 20 cm. apart. At this age, the plants that are pulled up can be used for salads or cooking, as may be desired. A distance of 15 to 20 cm. in the row and 50 cm. between the rows permits a sufficient space for the leaves of the plants to develop without being crowded and gives enough room to use the hand cultivator to keep up the soil mulch and to exterminate the weeds.

No definite rule can be given as to the depth at which seeds should be planted, because it varies with the character of the soil. In heavy and moist soils the covering should be lighter than in sandy or dry soils.

The plants were harvested July 3, 1915, with the results shown in the following table:

TABLE VII

<i>Plot</i>	<i>No. of plants harvested</i>	<i>Total weight in kilos</i>	<i>Average wt. per plant, in gm.</i>
Manure.....	558	37.92	68.0
Ashes.....	460	27.60	60.0
Mixture.....	420	22.89	54.5
Check.....	400	16.80	42.0

Mustard is ready for use in about five weeks from germination. If more tender leaves are desired, they can be used after four weeks. It took 40 days to mature mustard, with a rainfall of 24.96 cm.

SECOND CULTURE

There were only three successful cultures of mustard made, including the one grown from a selection of the second culture.

The plots from which the first culture of radishes was harvested were again fertilized with an application one-half as heavy as that used the first time.

The seeds were sown in drills, July 15, 1915. There being much rain during the first week some of the seeds were covered by the surface soil, causing the loss of some of them. After 10 days the crowded furrows were thinned and the vacant spaces planted.

The plants were not uniform. A great number of them were very small and of lighter color than those produced in the previous culture. They were harvested Sept. 3, when most of them showed signs of sending up flowering stalks.

TABLE VIII

<i>Plot</i>	<i>No. of plants harvested</i>	<i>Total weight in kilos</i>	<i>Average wt. of plant in gm.</i>
Manure.....	292	14.13	48.0
Ashes.....	301	12.61	41.82
Mixture.....	285	11.25	39.48
Check.....	270	8.10	30.0

This crop matured in about 50 days, with an average daily rainfall of 0.645 cm. or 32.46 cm. during the time when it was grown.

THIRD CULTURE

There were 13 exceptional plants of the second culture that were saved for seeds. They were staked and numbered. The seeds were gathered Sept. 28, and the seeds from each individual plant put in separate envelopes. They were then dried and cleaned. It was found that the seeds from three individual plants were too few and most of them abnormal, so only the seeds from the remaining 10 plants were sown in drills, the seeds from each plant planting three rows of four meters, or a row of 12 meters long and 50 cm. between the rows. Due to the scarcity of seeds they were sown thinly.

The number of plants harvested from each row and the weights are as follows:

TABLE IX

<i>Planted October 1st</i>		<i>Harvested November 15th</i>	
<i>Plant No.</i>	<i>No. of plants harvested</i>	<i>Total weight in kilos</i>	<i>Average wt. per plant in gm.</i>
I.....	48	2.314	48.2
II.....	51	2.55	50.0
III.....	63	3.08	49.0
IV.....	47	2.20	46.5
V.....	63	3.57	56.7
VI.....	58	3.14	54.2
VII.....	52	3.15	60.3
VIII.....	43	1.93	45.0
IX.....	50	2.52	50.2
X.....	67	2.84	42.0

Although there was considerable precipitation most of the days after the selected seeds were planted and up to the harvesting period, a good stand was secured as compared with the previous culture with a rainfall of 32.46 cm., only about one-half of 77.96 cm., the total rainfall while this last culture was grown. The soil on which it was planted (northwest of the new Laboratory) is

comparatively well drained. It dries up quickly, thus favoring the growth and stand.

The plants were somewhat injured during the storm of October 23, but recovered before harvesting. The plants from each row were of uniform size.

METHODS OF SELECTION

The production of cruciferous vegetables in the Philippine Islands can be improved by either one of the following methods of selection, namely: (1) by field selection, or (2) by mechanical selection.

Field Selection.—In all garden crops, as in general farm crops, there are always individual plants that are superior to the rest. In the case of the salad plants, superiority may be either in size and quality of the leaves, or of the roots, if these are desired. The superior plants should be staked and the seeds allowed to mature. The seeds should be gathered as soon as they are ready and dried thoroughly before planting or before storing.

Earliness of maturity is one of the most important factors that must be considered for most vegetables, particularly the salad plants. It has been found that there are certain exceptional plants that develop pods earlier than most of the remaining plants. Such plants should be selected and the seeds kept separately and stored properly.

Mechanical Selection.—In all vegetables the seed is a vital factor of high production, for it contains the germ and the food material to start either a strong and vigorous plant or a weak and undesirable plant. By thoroughly fanning the seeds or by other similar means, the imperfect seeds and dirt can be removed, leaving only the plump, clean seeds.

A good method by which light and diseased seeds and other impurities

can be removed is as follows: In a container partly filled with water, pour the seeds. Stir the water thoroughly. Undesirable seeds, etc., will float on the surface of the water. This water should be carefully drained off and the seeds dried in a clean place.

Generally the seeds sold in the stores are dirty. Either one of these two methods can be used to improve such seeds. Furthermore, these seeds may have been adulterated with seeds of the same kind that have lost their vitality, or with some similar-appearing seeds of weeds.

The plants grown from selected stock showed great uniformity. The general stand was greatly improved. The average weight of plants from several rows as shown in Table IX exceeded that of the highest average weight shown in Table VIII.

In the selection of mustard the points to be considered are uniformity of the plants, earliness of maturity and quality—that is, the flavor and the fineness of the leaves.

SOWING AND THINNING

Where either radishes or mustard are broadcasted, an inferior crop is produced. Sown in drills or in straight rows the seedlings will be more uniform in size and in shape, and thinning and cultivating will be more easily accomplished. In cases where the soil is not too wet it should be well pressed down just before sowing. After the seeds are sown and covered the surface should again be pressed by means of a smooth board.

Thinning should be done as soon as the plants are large enough to pull and before they begin to become spindling from crowding. The best plants should be allowed to remain, but due consideration should be given to the matter of proper spacing. The spaces should be

as uniform as possible. An inferior crop will invariably be the result of improper thinning. The row should be slightly ridged up so as to prevent the water from standing.

WATERING AND MULCHING

When rains occur during the growing season it should not be necessary to water. Water should not be applied unless needed. When necessary, the application should be thorough and in a very dry period at least two or three times a week. After watering, the land should be cultivated as soon as the surface becomes sufficiently dry; and no more water should be given until the plants begin to show the need of additional moisture. Apply the water at any time of the day that is most convenient, provided that the leaves are not wet.

A mulch of well rotted manure along the drills at the base of the plants will lessen the effect of drought, and will also prevent too rapid loss of moisture.

ENEMIES

Plant Lice.—These pests will be found to be very numerous at times on radishes. They are found chiefly on the lower part of the leaves, sucking up the juice, causing the leaves to become yellow and wilt. Plant lice were not as numerous on the mustard as on the radish.

Some of the contact insecticides, such as kerosene emulsion and tobacco water, should be applied in the form of spray, seeing that each insect is hit. Where tobacco dust is obtainable, as in the city of Manila, it should be used. Apply this dust in the evening around the plants which are attacked by these lice. This is common practice in all school gardens in the city of Manila.*

* Predaceous insects, notably the six-spotted lady beetle (*Chilomenes 6-maculata*) and a syrphid larva, help greatly to check the radish aphids.—EDITOR.

Flea Beetle.—Very often we will find this tiny black creature on the leaves of both mustard and radishes, especially on the former. As soon as you touch the plants, they jump suddenly. This little beetle riddles the foliage. You can readily distinguish the plants attacked by this beetle, because the leaves are perforated.

For radishes, Paris green, either in the form of solution or powder, should be used in combating this beetle. Since mustard is cultivated for its tender leaves, the same treatment should not be given, as Paris green is a strong poison. If mustard is properly cared for and grown under favorable conditions, it will grow so fast that this beetle can not damage it.

Raddish-Maggot.—Sometimes the radish wilts and turns yellowish in color. If pulled up, a tiny hole through the root can be seen. This is caused by the little maggot that tunnels through the root.

"The best remedy for the maggot when working in radish, seems to be the carbolic emulsion, diluted about 30 times with water. Sprinkle this along the rows of radishes about once a week. The odor drives away many of the flies that come to lay their eggs." (7)

"Dress heavily with unleached wood ashes after sowing or still more heavily with tobacco dust." (6) Sprinkle once a week with carbolic acid emulsion.

PLANTING MUSTARD AND RADISHES FOR HOME USE AND MARKET

If a constant supply of mustard and radishes is desired during the greater part of the year, these should be grown at home or in some place as near as desirable soil can be obtained. In this way any family can have a bountiful supply of fresh vegetables close at hand. The supply for the family is directly under control and often this is the only way whereby clean produce may be secured.

The area to be planted or the amount to be grown at a time depends upon the daily demands of the family. These home vegetable gardens do not involve toilsome labor. Even the business man has time for it. Once a piece of ground is prepared properly for planting only a little attention is required. The principal interest in the home garden is manifested by the women of the household and much of the necessary care can be given by them.

Mustard and radishes will grow best in a small piece of ground, since the conditions there are uniform and it can easily be placed in the proper tilth necessary for quick growth. Just after the seeds are sown, either in drills of 25 to 30 cm. apart or broadcasted, the only care to be given is protection from the enemies, if there be any, and watering and weeding when necessary, all of which can be done by members of the family at spare times. A weekly sowing is needed in order to have a continuous fresh supply. Either the plant may be pulled when large enough to use or individual leaves plucked off.

If there is no available ground space at home these vegetables can be grown in boxes or in any framework filled with fine soil about 15 cm. or more in depth. Mustard and some of the turnip-rooted forcing varieties of radishes can be most successfully grown this way, as they are not long-rooted.

For Market.—The most important factor that should be considered in the production of these salad plants for market is the quality. If the planter ever expects to win against competition, especially when mustard and radishes are so plentiful in the markets, his produce must be of superior quality.

The field should be as near as possible to the market where the produce will be sold. Since these crops are planted by the natives only during a certain part

of the year, the greatest gain can be obtained in the season when most of the planters are not growing them. Mustard and native radishes can be grown throughout the greater part of the year if the soil is so prepared as to make its physical condition such as to meet the requirements of the plants at different seasons.

The distances between the rows depend upon the kind of tools to be used for cultivation and the area to be planted. If a wheel-hoe is to be used, a distance of 45 to 50 cm. is sufficient. If a large area is to be planted, the distance between the rows should be at least one meter to permit the use of an animal cultivator. Where the land is dear and only of limited area the Chinese method of planting in the gardens in Manila should be practiced. There the seeds are broadcasted in the soil after it has been given perfect preparatory tillage, so that no further care is necessary except daily waterings during the dry season. The seeds after sowing are covered thinly with rice straw in order to lessen the rapid evaporation of water. The radishes are allowed to mature on the plot where they were first sown, while the mustard is thinned when the plants are at the third or fourth leaf, and transplanted to other plots, the young seedlings being set close together so that when they are about to mature one can not see the ground, looking from above.

For fertilizer the Chinese gardeners use "lumbang cake." The latter is applied after preparing the land and just before planting. Usually the vegetable dealers come to the gardens of these Chinese and contract for all plants grown on a given area.

If a planter finds difficulty in sowing mustard seeds during the rainy season in the permanent field, they may be sown first in seed flats. When at the

second leaf they should be transplanted into pricking flats, giving the seedlings enough space to become stocky. Long and spindling seedlings must not be transplanted, as they will not be able to withstand rains or direct sunshine. This method of first sowing the seeds in flats can be practiced even during the driest months of the year, provided that the soil is favorable and the plants given a liberal supply of water to keep the soil always moist. Newly transplanted seedlings must be shaded on sunny days until they are well started. Transplanted mustard will generally grow larger and bring a higher price than that sown directly in the field.

CONCLUSIONS

The native radish was ready for harvest within 45 days at the beginning of the wet season, 50 days in the middle part, and 40 days at the latter part. The roots produced in the middle part of the wet season, although smaller, were mild and crisp.

Animal dung, ashes, and their combinations, are the cheapest and most profitable fertilizers that can be obtained in this country for those vegetables. A mixture of horse manure and ash gave the best results for the production of radishes. Next to this is the ash.

Some of the foreign varieties of radishes that have been tested are ready for harvest in from three to four weeks.

Mustard matured within 40 days at the beginning of the wet season, 50 days in the middle part, and 46 days in the latter part. Mustard grown in the middle part of the wet season is generally of light color.

Manure gave the best results for the production of mustard.

The native radish and the mustard can be grown in the rainy season, provided that the soil is sufficiently drained.

By selection of mustard seed, uniformity of the crop and an increase in production can be secured.

From these experiments we can conclude that the stand of these vegetables can be greatly improved by proper preparation of the soil, cultivation and fertilization.

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Observations on Coconut Seedlings

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Thesis Presented for Graduation from the College of Agriculture, No. 59.

INTRODUCTION

The coconut industry in the Philippines may be improved:

1. By seed selection from the most excellent strains.

2. By proper distances of planting.

3. By harvesting the nuts at proper times.

4. By proper methods of manufacturing the market products of the coconut.

5. By judicious application of manures, natural or artificial.

A. Seed Selection.—It is a common practice among the coconut planters in the Philippines to pick out the seed from a pile of nuts gathered from all the trees in the grove. As is commonly the case, the largest, best-looking nuts in the pile are from trees bearing but few nuts to the bunch. The selection from the pile of these big and nice-looking nuts for seeds will tend to increase the number of poorly producing trees. The farmers should focus their attention on the valuable characteristics of the coconut *trees*, and they should select their seeds while the nuts are still on the trees. Coconut growers know, for instance, that the nuts taken from a bunch in which macapunó (a coconut whose entire internal cavity is full) is found will also produce makapunó nuts, but in selecting their seed for trees to produce copra they fail to apply such knowledge. The trees from which the seed nuts should be taken should be exceptionally and regularly productive.

B. Distances.—The notion of many coconut planters in the Philippines is that the more trees they plant in a given area, the more nuts will be produced by them. When the trees are planted too close together they can not develop normally. On the other hand, too

wide spacing wastes land. Ten meters between trees is, in general, a proper distance.

C. Harvest.—Harvesting at the proper time will improve our copra. The nuts should be harvested only when they are "dead ripe." One of the reasons Philippine copra is poor is because the nuts are harvested before they are mature.

D. Proper Methods of Manufacturing Products.—The poor quality of most Philippine copra, due partly to poor drying, tends to lower the sale price of all of it, and yet the men who dry it best receive more than a peso a picul more than is paid for the bulk of the product.

E. Application of Manure.—Manure is a substance which, when applied to the crops in the right place, in the right way, at the right time and in the right amount makes the plants grow faster and produce more than they would without it. When there is more competition in producing the greatest possible yield from coconuts, planters will begin to appreciate the value of fertilizers.

EXPERIMENT ON FERTILIZATION

The object of this experiment is to study the effect of different combinations of fertilizers on the growth of seedlings after transplanting. As the College did not have seedlings ready for this experiment, the preparation of the materials was the first step. One thousand and forty-five coconuts were gathered from the College trees and thirty-four nuts were brought in from Pangasinan and La Union provinces.

Some of the nuts were picked up from the ground and some were gathered from the trees. The nuts from the trees were gathered by letting them

down to the ground by means of a rope. Some of them were not fully ripe when collected.

Before planting the nuts, the length, thickness and perimeter were measured and recorded, in order to find out whether in the daughter crop there would be a change in size and shape due to the action of fertilizers, or whether size and shape would be inherited.

On May 20, 1914, the planting of the seed nuts was started. The nuts were planted 30 cm. apart in rows, and the rows were 40 cm. apart.

Each of the nuts was labeled with a tin tag bearing the number of the seedling. This tag is useful in any observation

of the tree, and should not be removed from any tree. In order that anybody can tell the number of the tree, even though the tag is not there, the plantation was mapped after all the trees were planted. The same thing was done in the nurseries, both in the experiment of the author and that of the Agronomy II class. All the coconut groves of the College have their own maps. The number of any tree can be found, even though the tag be lost.

Five days after planting, the first sprout appeared. From this time on the appearance of the sprouts was recorded. The number of nuts germinating daily is shown in the following table:

May.....						20	21	22	23	24	25	26	27	28	29	30	31
Sprouted.....											2	0	0	1	1	0	0
June.....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Sprouted.....	5	4	9	5	7	4	7	11	4	6	4	12	5	12	13		
June.....	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
Sprouted.....	15	3	5	12	4	5	3	2	5	11	11	16	8	13	12		
July.....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Sprouted.....	27	13	12	28	22	15	24	28	26	29	15	30	15	20	19	11	
July.....	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
Sprouted.....	18	14	28	19	13	9	21	22	19	17	11	16	20	10	14		
August.....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Sprouted.....	17	15	18	12	18	17	11	6	8	2	3	10	1	7	0	2	
August.....	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
	0	1	0	1	0	0	4	0	0	1	1	0	0	0	0		

The table above shows that most seedlings germinated in the second month after planting in the seed bed. During the first and the third months fewer nuts germinated. In the fourth month the germination stopped. The meat of those that had not germinated by this time was rotten. Ninety-three per cent of 1079 nuts sprouted; ten per cent were sickly, slender and weak. Therefore, only about eighty-three per cent were good for transplanting. Selection of seedlings from the nursery stock will add something to the future average vigor of the trees.

The emergence of the shoots was partly hindered by the hard part of the

husk. Instead of passing through the hard husk the shoots continued to grow under this, until they reached the softer part where they broke out. This can be helped by slicing off a part of the husk and putting the sliced part on top when planting in the seed bed. This is especially advisable when the nuts are scarce and expensive. When the seedlings had begun to develop before the nuts were placed in the seed bed, some of them pointed downward and the shoots died in the soil. Delay in planting the harvested nuts may thus decrease the percentage of effective germination in the nursery.

Beginning July 19, 1914, a monthly growth record was kept. At this time the measurement was based on the increase in total height. During the dry season the tips of some of the highest leaves dried, and this interfered with the growth record. In January, 1915, new marks at the bases of the petioles were made, according to the method used in measuring old trees (E. B. Copeland, *The Coconut*, p. 17). When the youngest leaf was not the highest, the growth was about four times faster than the first method shows. The following table shows the details of this determination:

Tree No.	3-3-16				3-7-16			
	Total cm.	Height cm.	Petiole cm.	Marks cm.	Total Height cm.	Increase cm.	Petiole cm.	Growth cm.
A-2k	88.0	0	0	0	83.5	1.5	5.8	5.8
A-3a	92.5	0	0	0	90.0	1.5	6.5	6.5
A-2o	100.0	0	0	0	101.0	5.5	5.5	5.5
A-7f	67.5	0	0	0	68.0	0.5	4.0	4.0
A-2i	87.0	0	0	0	87.5	0.5	5.0	5.0
A-2b	84.5	0	0	0	86.0	1.5	5.5	5.5
A-1o	78.0	0	0	0	83.0	5.0	5.0	5.0

Note:—The highest leaf of Nos. A-1o and A-2o is the youngest.

During the dry season the seedlings were watered twice a week, yet many seedlings wilted. Cowpeas were then planted between the rows. The vines and leaves covered the ground and prevented the rapid evaporation of water. Cowpeas are rapid growing plants and do not suffer very much from drought. They are good cover crops for coconuts.

After eight months the leaflets of the seedlings began to separate from each other. At this time the seedlings had developed from five to ten leaves. The separation of pinnae began on the fifth leaf. When conditions were less favorable, this did not take place even on the tenth leaf, especially when the seedlings were under heavy shade.

TRANSPLANTING

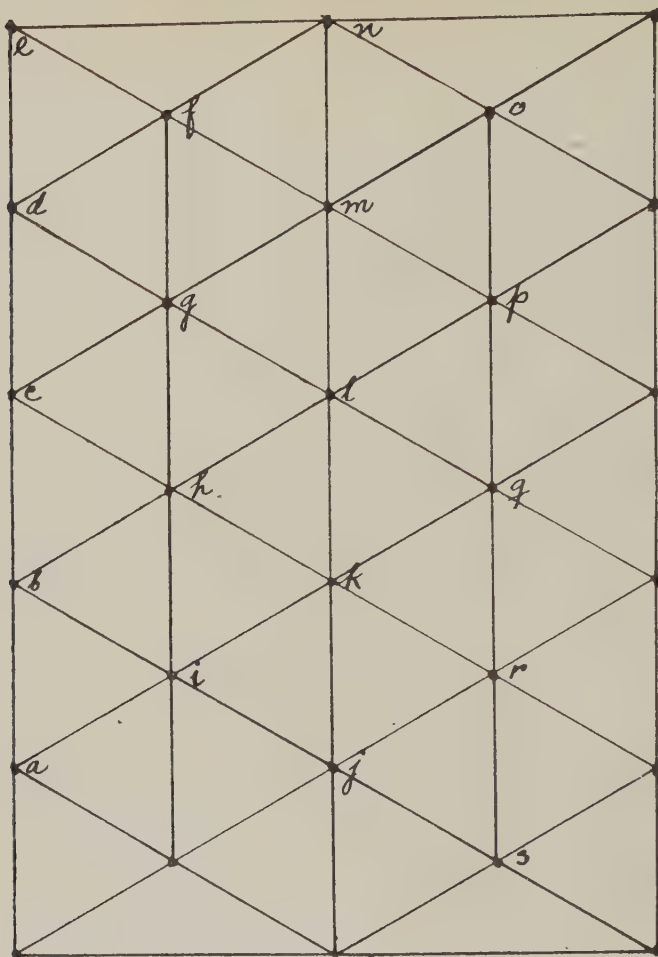
Of the land used for this work about half was cogonal and the other half had been previously covered with trees. The cleaning and transplanting were done simultaneously, that is, the transplanting was done on the cogon land while the wooded part was being cleared and burned. The few trees on the cogon land were cut down.

The holes were located according to the triangular or quincunx plan. They were staked as follows.—Parallel to and five meters from the fence, the straight side of the field, a row of stakes, *e*, *d*, *c*, *b*, and *a*, ten meters apart, was established. Then a man with the end of a ten-meter chain stood on the point *a*. The second man with the end of another ten-meter chain stood on the point *b*. The third man, holding the ends of the two chains, drew them taut. The point where their ends met determined the third point *i*. The man at the point *a* then moved to *i* and the one on *i* stretched the chains until their ends met at point *h*. Then the man of *b* moved to *c*, and the man on *i* moved to *h*, while the man on *h* moved until the chains were stretched. The ends of the chains met at *g*. Continuing the process quincunx stakes were established.

Holes 70 cm. wide and 50 cm. deep were prepared from twenty to fifty days before transplanting.

The holes were about one-third filled with surface soil and the fertilizers were mixed with this soil thoroughly. Then a thin layer of surface soil was put over the fertilized soil, before the seedlings were put into the holes. After putting the seedlings into the holes they were covered with the surface soil.

The fertilizers used were sulphate of ammonia containing 20% nitrogen, muriate of potash containing 40.49%



potash (K_2O), and single superphosphate containing 20% phosphorus pentoxide (P_2O_5).

The following fertilizer-constituents and combinations were used: N, P, K, 2KNP, KNP, $\frac{KNP}{2}$, KP, NP, KN. The amounts of the several fertilizers were calculated on the basis of Walker's analyses (5). In deciding upon the amount to be applied, the intention was to supply for each seedling, when transplanted, $\frac{1}{20}$ as much mineral food and nitrogen as an adult tree consumes in one year; by a mistake in computation, the amount actually applied was $\frac{1}{20}$ of the amount of fertilizing material lost by the tree in one nut and one leaf.

This amount was naturally too little to produce any positive effect.

The trees in this series were transplanted in January, 1915. Growth measurements were made at intervals of four weeks from the time the first leaves appeared in the seed bed. The following table shows the average growth of each lot of trees from October 8, 1914, to December 30, 1915. Each number in the table is the average of the measurements of ten seedlings and therefore gives little expression to any individual variation. The first four horizontal lines represent growth in the seed bed, the next represents growth during the month when transplanting occurred, and

the succeeding ones represent growth of the seedlings in their permanent places. It will be observed that transplanting took place at the beginning of the dry season. The table shows, better than any argument could do, the serious bad effects of transplanting at such a time. It is clear that recovery from transplanting hardly took place at all

until after the beginning of the rainy season in June. For several months, after that time, there was a steady increase in rate of growth.

The measurements used as the basis for this table are of the total height of the plant, from a fixed point at about the level of the ground, to the tip of the highest leaf when held in an erect position.

AVERAGES OF MONTHLY GROWTH OF TEN COCONUT SEEDLINGS

Dates	I cm	II cm	III cm	IV cm	V cm	VI cm	VII cm	VIII cm	IX cm	X cm
10- 8-14	21.32	22.63	22.48	24.76	18.74	24.27	22.86	23.21	21.97	25.87
11- 5-14	16.33	19.19	18.69	21.43	23.01	16.25	22.36	19.81	17.27	18.24
12- 3-14	10.83	15.55	9.94	9.61	10.16	7.04	10.71	9.13	9.08	7.70
12-31-14	13.75	17.64	14.86	15.49	15.02	11.65	13.73	12.16	17.15	14.09
1-28-15	3.34	6.00	3.80	3.47	2.39	2.62	5.02	3.29	4.53	3.07
2-25-15	8.42	4.35	6.25	3.42	0.93	4.61	5.14	2.36	0.70	0.84
3-25-15	6.41	6.21	8.48	3.14	6.54	1.89	3.38	4.10	1.56	1.99
4-22-15	3.73	2.60	2.96	3.09	3.30	1.43	2.97	2.53	1.26	1.74
5-25-15	5.47	4.21	5.66	6.23	6.51	3.37	4.97	4.48	3.65	2.87
6-17-15	9.79	7.63	10.06	11.65	11.17	7.87	8.75	7.77	7.18	4.86
7-15-15	14.90	13.05	15.38	18.40	16.02	13.03	13.15	11.92	12.02	10.41
8-12-15	25.59	19.15	21.20	25.38	22.30	19.84	18.89	16.87	18.61	17.25
9- 9-15	32.28	25.40	31.38	40.90	34.90	29.30	26.62	23.23	29.57	27.45
10- 7-15	40.68	29.39	43.49	47.30	49.76	41.38	33.53	29.45	32.69	27.41
11- 4-15	47.49	42.31	38.72	45.59	46.87	45.48	39.37	37.29	37.45	40.00
12- 2-15	59.30	44.81	62.72	60.59	53.92	53.93	47.86	48.65	67.16	64.24
12-30-15	42.26	28.13	38.67	53.63	47.32	35.91	33.79	30.88	39.26	40.17

The cost of application per tree, the fertilizer-constituents and combinations and the monthly average growth of the

ten seedlings in each lot are shown in the table below.

SERIES I

I P	II P	III P	IV P	V P	VI P	VII P	VIII P	IX P	X P
0.0128	0.0065	0.0451	0.0342	0.0032	0.0029	0.0024	0.0044	0.0041	0.00
2KNP cm	KNP cm	KP cm	K cm	KNP $\frac{2}{3}$ cm	N cm	P cm	NP cm	KN cm	Check.
24.53	17.78	23.75	24.95	24.96	21.50	19.95	18.46	20.09	23.27

Note: Lot X is check.

Comparing the average of growth of the ten trees under each lot it is found that Lot V gave the highest average. But the difference between this and the control is very little. From this it is concluded that the fertilizers used in this series probably have not shown any effect.

SERIES II

The following combinations of fertilizers were used in Series II: N, P, K 2KNP, KNP, $\frac{2}{3}$ KNP, KP, NP, KN, $\frac{2}{3}$ KNP, KNP, 3KNP, 4KNP, 5KNP, 6KNP, 2 kilos dried blood, 1 kilo kainit, 0.5 kilo nitrate of soda, and 2 kilos panique guano. In this series, K stands

for 96.6 gm. muriate of potash, N stands for 131.6 gm. sulphate of ammonia, and P stands for 59.8 gm. single superphosphate.

The calculation was based on the assumption that a seedling would require one-twentieth of the total amount lost from a tree per year, the latter amount being then "20KNP," as the letters are here used. In this series it was thought that some of the trees might suffer because of the strength of the fertilizers applied, but until now the differences in growth between the fertilized lots and the control are not very great.

The next table, in two parts, shows the growth, for intervals of four weeks, of the plants of the second series, from October 10, 1914, to February 24, 1916. As in the previous table, each number here is the average of ten measurements; the total number of measurements serv-

ing as the basis of this table is, therefore, approximately 4,000. The plants in this series passed the dry season in the seed bed before transplanting. The effect of this particular dry season, which was quite a severe one, on seedlings less than one year old and therefore without extensive root systems, is plainly manifest. However, the checking of growth of these uninjured plants is decidedly less marked than that of the transplanted seedlings of the preceeding series. It was impracticable to transplant all the plants of this series at one time. The horizontal line in the table shows the interval during which transplanting occurred. It will be observed that in this case the plants were so little injured by the act of transplanting that the acceleration of growth which normally occurred during the rainy season was not prevented.

SERIES II
AVERAGES OF MONTHLY GROWTH OF TEN FERTILIZED SEEDLINGS
FERTILIZING
PART I

Dates	Table I* cm	Table II cm	Table III cm	Table IV cm	Table V cm	Table VI cm	Table VII cm	Table VIII cm	Table IX cm	Table X cm	Table XI cm
7-19-14											
8-16-14											
9-10-14	20.92	18.12	19.44	22.19	21.35	23.02	22.64	23.35	21.15	22.80	21.96
10- 8-14	17.95	20.76	23.85	24.76	18.60	25.37	24.74	22.60	24.01	23.92	25.98
11- 5-14	14.55	14.84	18.94	20.78	18.07	16.11	18.77	17.84	16.57	20.25	17.94
12- 3-14	12.25	7.78	9.67	6.43	12.18	10.39	8.52	11.10	10.36	9.75	11.35
12-31-14	18.77	16.58	15.67	16.42	20.15	13.24	18.13	21.76	16.34	15.97	18.57
1-28-15	5.78	8.74	15.62	14.82	12.72	10.95	7.85	11.77	14.56	14.30	12.21
2-25-15	5.56	6.56	9.12	8.59	9.91	7.94	8.66	7.75	10.81	6.38	8.45
3-25-15	8.29	6.34	8.45	7.69	7.20	6.35	4.15	5.32	8.16	5.57	3.45
4-22-15	3.40	3.35	3.20	3.34	3.10	3.50	2.79	4.10	4.27	3.11	4.01
5-20-15	5.52	4.80	3.14	4.05	2.96	4.16	3.39	3.63	4.08	3.41	4.27
6-17-15	10.72	9.61	5.47	7.04	5.56	8.03	5.51	5.77	5.78	6.31	7.18
7-15-15	16.98	14.20	9.54	10.24	8.78	10.93	9.03	10.91	8.36	8.88	9.24
8-12-15	26.35	20.64	15.63	12.40	13.75	13.79	13.87	16.01	12.18	13.89	12.17
9- 9-15	36.57	27.55	19.25	16.45	18.75	19.15	17.41	20.05	16.87	16.48	16.51
10- 7-15	40.68	32.60	21.78	23.05	20.27	24.36	32.71	23.19	20.88	23.73	18.83
11- 4-15	34.83	32.48	22.67	31.64	19.17	20.32	28.97	22.68	19.12	19.37	14.20
12- 2-15	58.62	40.75	40.55	45.60	35.62	42.60	45.07	47.86	44.26	45.62	43.04
12-30-15	49.20	36.03	27.04	34.89	32.98	40.58	36.01	26.34	37.07	28.88	32.60
2- 7-16	40.60	31.53	28.03	36.66	41.55	29.67	28.98	44.28	40.57	38.55	30.16
2-24-16	43.25	35.90	28.98	37.65	27.65	28.75	23.45	31.20	42.70	41.05	40.75
3-23-16											
4-20-16											
5-18-16											
6-15-16											

* From original table I, showing growth of the individual trees.

SERIES II

PART II

Dates	Table XII cm	Table XIII cm	Table XIV cm	Table XV cm	Table XVI cm	Table XVII cm	Table XVIII cm	Table XIX cm	Table XX cm
7-19-14									
8-16-14									
9-10-14	26.02	20.97	25.16	21.73	27.21	25.75	24.49	23.51	22.74
10- 8-14	29.17	25.14	26.82	26.02	29.94	25.18	29.61	26.65	19.17
11- 5-15	22.03	15.95	19.74	28.24	19.64	20.66	19.71	21.68	20.23
12- 3-14	6.86	8.56	10.52	9.08	8.02	11.55	8.51	16.59	7.03
12-31-14	15.74	17.03	21.15	16.73	10.67	12.89	16.99	17.53	15.93
1-28-15	14.72	9.49	13.36	14.75	15.63	14.39	13.11	13.85	9.21
2-25-15	9.76	9.30	7.86	6.81	7.00	11.55	6.38	6.26	8.47
3-25-15	5.78	4.03	3.91	5.12	5.55	6.37	4.91	4.78	8.56
4-22-15	4.49	4.53	3.75	3.90	5.13	2.26	6.12	3.96	6.77
5-20-15	3.21	3.60	4.59	4.80	3.52	3.42	4.72	4.61	7.02
6-17-15	6.70	7.68	6.25	6.78	6.12	8.59	9.75	7.09	10.03
7-15-15	8.44	8.71	12.25	8.48	11.30	10.00	16.40	10.69	13.22
8-12-15	12.78	10.74	15.32	12.41	14.55	16.40	23.08	13.15	15.20
9- 9-15	15.75	11.79	16.25	14.72	15.77	22.18	32.73	15.90	21.49
10- 7-15	16.91	24.08	20.45	16.58	19.26	27.60	22.28	18.55	34.47
11- 4-15	19.99	22.88	21.07	21.53	24.69	25.49	23.26	23.22	32.25
12- 2-15	40.43	45.98	40.37	35.49	42.13	40.23	16.64	27.94	42.43
12-30-15	31.32	37.58	32.63	37.55	39.19	39.97	16.81	37.06	34.62
2- 7-16	36.45	30.90	34.15	36.34	40.03	45.95	32.87	30.77	32.91
2-24-16	37.10	36.80	33.65	38.70	37.60	37.70	11.50	23.11	30.50

The following table shows the fertilizers used, the cost of application per tree (including transportation, but not labor), the dates of transplanting and the average monthly growth during the period after transplanting.

SERIES II

I N	II P	III K	IV 2KNP	V KNP	VI KNP ₂	VII KP	VIII NP	IX KN	X KNP ₃
P	P	P	P	P	P	P	P	P	P
0.026	0.003	0.015	0.087	0.044	0.022	0.018	0.029	0.041	0.015
6-26-15	6-26-15	7-3-15	7-7-15	7-7-15	7-8-15	7-9-15	7-10-15	7-10-15	7-20-15
cm	cm	cm	cm	cm	cm	cm	cm	cm	cm
42.12	33.78	26.99	33.19	25.39	27.98	26.26	29.92	24.99	33.85
XI KNP ₁	XII 3KNP	XIII 4KNP	XIV 5KNP	XV 6KNP	XVI 2 kilos dried blood	XVII 1 kilo kainit	XVIII 0.5 kilo Na No ₃	XIX 2 kilos panique guano	XX Check.
P	P	P	P	P	P	P	P	P	P
0.011	0.131	0.174	0.218	0.262	0.182	0.061	0.081	0.189	0.000
7-24-15	7-24-15	7-26-15	7-27-15	7-29-15	7-31-15	8-5-15	10-14-15	7-31-15	June to Oct. 1915
cm	cm	cm	cm	cm	cm	cm	cm	cm	cm
32.34	30.95	31.54	29.70	31.82	32.78	35.64	20.50	23.40	33.57

The highest average growth is found in Lot I. Each tree in this lot was fertilized with 131.6 gm. sulphate of ammonia containing 20% nitrogen. Each tree received 26.33 gm. pure nitrogen. Comparison with No. XVIII shows that

application of 80 gm. pure nitrogen in the form of nitrate of soda resulted in growth slower than that of the check. This result is attributed to the effect of the fertilizers. A possible objection to this conclusion is that the seedlings

fertilized with nitrate of soda were planted later than most of the others; but their growth was apparently not disturbed by transplanting. The trees in Lot XVII showed the second highest growth, and those in lot X the third highest.

CONCLUSIONS

1. While nuts should not be planted in the seed bed before they are thoroughly ripe, it is likewise undesirable that their planting be delayed much after this time. The danger in this case is that the plumule will be fixed in its direction of growth inside the husk and that a deformed seedling will result from placing the nut in a different position.

2. The most rapid growth of transplanted seedlings during the first three months resulted from the application of 131.6 gm. of ammonium sulphate.

3. Larger applications of fertilizers were less helpful or at any rate less immediately beneficial. The greatest interference with growth was observed after the application of 500 gm. of nitrate of soda.

4. As far as this work has been carried, it has not yet been demonstrated that the application of any commercial

fertilizer is sure to be profitable. Such a conclusion will perhaps be justified by the future behavior of these cultures.

RECOMMENDATIONS

1. Seedlings are ready to be transplanted immediately after germination is evident, and should be transplanted as soon as possible after this time.

2. Transplanting is possible without injury at the beginning of the rainy season and should be practised at this time only.

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Campus Notes

Associate Professor Banks of the Department of Entomology returned from leave in the United States in January and took charge of the work which for the early part of the year had been carried on by Mr. Uichanco under Professor Baker's direction. Since his return, Professor Banks has been given the additional title of head of the Department of Entomology.

At the industrial exposition held in connection with the Manila Carnival, the College of Agriculture occupied two booths, devoting one to fungous and bacterial enemies of plants and the other to the insect enemies. A number of students attended to the explanations called for by visitors. Although occupying a somewhat technical field, and one not of interest primarily to city crowds, the exhibit of the college was received with evident interest and appreciation.

Work in plant pathology was first seriously and effectively established in the Philippines by the arrival last July of Mr. Otto A. Reinking, Assistant Professor of Plant Pathology. Since his arrival, Mr. Reinking has located the organisms responsible for a considerable number of the diseases of our crops and has shown that an unsuspected number of these are due to bacteria. His chief subject of investigation has been the bud rot of the coconut. He has succeeded in this work in isolating the organism responsible for the disease, growing it in pure culture, making an inoculation from this culture and causing the disease, and from the diseased specimens so produced, in re-collecting pure cultures of the pathogenic germ. The microbe in question is a bacterium but does not belong to the group of *Bacillus Coli*. It is recalled that the bud rot of the Delta of the Godavari River in India is supposed to be caused by a fungus, and

that the bud rot of Cuba is supposed to be caused by *Bacillus Coli*. If confidence may be placed in the observations independently made in the three regions, one must conclude that, although there are no constant and reliable differences in symptoms, in the course of the disease, or the practically invariable fatalness of attack, the responsible organisms are in each case distinctive, and, so far as known, local in their effect as bud-rot producers. Mr. Reinking's work is almost ready for publication in full.

On the suggestion of the Director of Education, an attempt was made this year to make a small exhibit illustrating some of the work of the College of Agriculture, at school garden days, in the principal towns of Laguna. Difficulty in meeting dates developed so that the exhibit was made in but few places. It was exceedingly well received where exhibited, so that it may be hoped and anticipated that such exhibits will in the future be a common feature of school garden day celebrations.

The University has cabled to the United States, asking the appointment of Mr. S. F. Trelease as Assistant Professor of Plant Physiology, with the expectation that he will be here for work at about the beginning of the next school year.

At a meeting of the University Council held March 17, it was decided that, effective in April, 1918, the requirements for admission to the six year course in the College of Agriculture should be raised to include two years of high school work. Putting to rest rumors that a change might be made without advance notice, the Council also decided that, for the coming one year, entrance requirements will remain as in the past. The Council at the same time recommended some changes in the course

of study which require the approval of the Board of Regents before they are effective. Among these is the substitution of a moderate amount of practical farm work and of instruction of Rural Economics and Farm Accounting, these subjects, altogether, to take the place of the German hitherto given during the first two years of the six year course.

Since the last commencement, Dionisio R. Tuason and Paul Villyar have completed the work leading to the degree of bachelor of agriculture which they will receive at the coming commencement.

Mr. José de Leon of the class of 1915 has been employed since graduation in charge of the development of a nursery, principally of fruit trees, near the city of Jolo. Two former graduates, Agripino Constantino and Alfredo Adriano, are employed in the Department of Mindanao and Sulu as teachers, and Teodorico Ghofulpo has recently gone there in the same capacity. During the past year, Marcelo Crisóstomo was stationed in the Cotabato Valley for a time as technical adviser to the agricultural colonies located there. The College has now been called upon to supply three more teachers, each to take charge of a nursery, an agricultural adviser for the San Ramon Penal Colony, and a number of deputy-governors for the several provinces which comprise the department. Another graduate during the early days of the college, Sotero Albano, has been selected to oversee technical aspects of Castilloa rubber cultivation on the Malita plantation in Davao. From the demand for our graduates to begin work in Mindanao this year, it would seem safe to conclude that those who have gone before have been a credit to the institution.

As has become usual, the College will hold a summer session during April

and May. The only subjects now announced in advance to be taught at this time are Botany I and Zoology I. If any other subjects are taught, it will be by special arrangement and only for students already in the college.

A considerable number of Filipino graduates of American colleges of agriculture have joined with the alumni of our own college in forming The Philippine Society of Technical Agriculturists. Mr. José Sanvictores, B. S. A., an alumnus of the University of Illinois, is President of the new organization; Inocencio Elayda, B. S. A., Iowa State College, M. S., University of the Philippines, is Vice-President; and Silverio Apostol, B. S. A., Indiana University, Secretary. The first public work undertaken by the new society is an investigation of the economic conditions justifying the present propaganda in favor of immigration to Mindanao. The committee appointed to investigate this question, by a visit to the southern Islands, consists of Mr. Elayda and Mr. Apostol, who expect to leave for this purpose about the first of May. The expenses of this trip are covered by a donation made for the purpose by the Honorable Teodoro Yangco.

A bill appropriating ₱125,000 for the establishment, in connection with the College of Agriculture, of an agricultural experiment station, was passed by the House of Representatives during the last days of the Legislature but reached the Senate too late to be acted upon.

More than a year ago, the Director of Forestry recommended to the University Council that courses more advanced than the Rangers' Course, and leading to a degree, be no longer offered. Regarding this as an expression of a particularly mistaken and unfortunate policy, which would necessarily be cor-

rected in time, we have delayed comment until we are now able to announce that, on the recommendation of the new Director of Forestry, new courses leading to a degree have been adopted by the University Council and approved by the Board of Regents. The new plan of study is believed to be materially stronger and fuller than the one which was previously in effect. It is expected that a number of graduate rangers will, during the coming year, avail themselves of the new courses offered.

The annual field trip coming between the junior and senior years of the Rangers' course is this year, as in 1914, being made in the northern Laguna forest, back of the towns of Paete and Pañgil. Assistant Professors Gillis and Weaver stay in the field through the entire trip, while Dr. Foxworthy is out for the first week only. Dr. McLean is also making the trip as an interested visitor.

At the Rangers' graduation exercises, held in the College Auditorium March 14, the following students received diplomas for completing the Rangers' course: Afalla, Pedro A.; Babao, Sixto; Baculi, Mauro S.; Causing, Ptolomeo; Colcol, Teodoro M.; Cristobal, Braulio V. A.; Defensor, Vicente J.; Guieb, Bernabe; Guzman, Deogracias E.; Laguio, Leonardo Sotto; Laraya, Sixto; Legaspi, Nicanor; Malana, Manuel F.; Martelino, Pastor; Montalvo, Manuel; Ramirez, Inocencio; Sajor, Valentin; Santos, Nicanor E.; Simeon, Macario; Tomeldan, Perfecto; Villafior, Vicente J.

An appropriation was made by the recent Legislature to provide for the

completion of the students' houses on the new site of the Forest School and for the improvement of the road leading across the College campus and to the Forest School building.

Campus events of more general than technical interest include the opening of a chapel and a reading room on ground adjoining the College, by the Presbyterian Mission. In the concrete building serving these purposes, Dr. Charles R. Hamilton is now holding services three Sundays of each month.

In athletics, the College of Agriculture lost the championship in baseball and basket ball, and for the first time in a number of years was the winner in the intercollegiate field day this year.

Considerable excitement was caused on the campus in January by the capture by Tomas Collado, bare-handed, of a king cobra more than three meters in length. The snake was kept alive as a trophy, and, a few days later, escaped. Seventeen days after its disappearance, it was found in the insect breeding house, where it had doubtless spent the entire time, and may be imagined playing about the feet of the students at their work. Collado was called upon to recapture his pet, which he did as before, but this time the snake was promptly executed out of respect to public safety. A few days later, the same boy, Collado, attempted to catch one of the pit vipers while it was coiled and ready to strike. The snake drew first blood, but Collado brought it in alive, and was pronounced out of danger after five days in the hospital. Snakes are not common on the campus, but, like everything else, those which are here grow large and vigorous.

